# Assignment-based Subjective Questions

1. From your analysis of the categorical variables from the dataset, what could you infer about their effect on the dependent variable? (3 marks)

**Ans:-**

The categorical variable in the dataset are :-
**season, yr, mnth, holiday, weekday, workingday, weathersit**

After plotting the boxplot of these with the target variable 'cnt' we can conclude :-

1. Season :-
   - Spring had least values of 'cnt'
   - Fall had max values of 'cnt'
   - Summer and Winter had intermediate values of 'cnt'
2. Yr – The number of rentals in 2019 was more that 2018
3. Mnth - Sep had the maximum number of rentals whereas Jan has the lowest. This is inline with the Season data in point 1.
4. Holiday – The rentals is seen to reduce on holidays
5. Weekday – The rentals is seen to be low on Sunday and Saturay as compare to the working weekdays (Monday to Friday)
6. Workingday – The rentals are seen to be lower on a non-working day that a working day
7. Weatherist :-
   - No rentals in the Heavy Rain + Ice Pallets + Thunderstorm + Mist, Snow + Fog weather
   - Rentals are Highest in - Clear, Few clouds, Partly cloudy, Partly cloudy weather
   - Rentals are Lowest in - Light Snow, Light Rain + Thunderstorm + Scattered clouds, Light Rain + Scattered clouds weather
   - Rentals are intermediate in - Mist + Cloudy, Mist + Broken clouds, Mist + Few clouds, Mist weather

2. Why is it important to use drop_first=True during dummy variable creation? (2 mark)

**Ans :-**

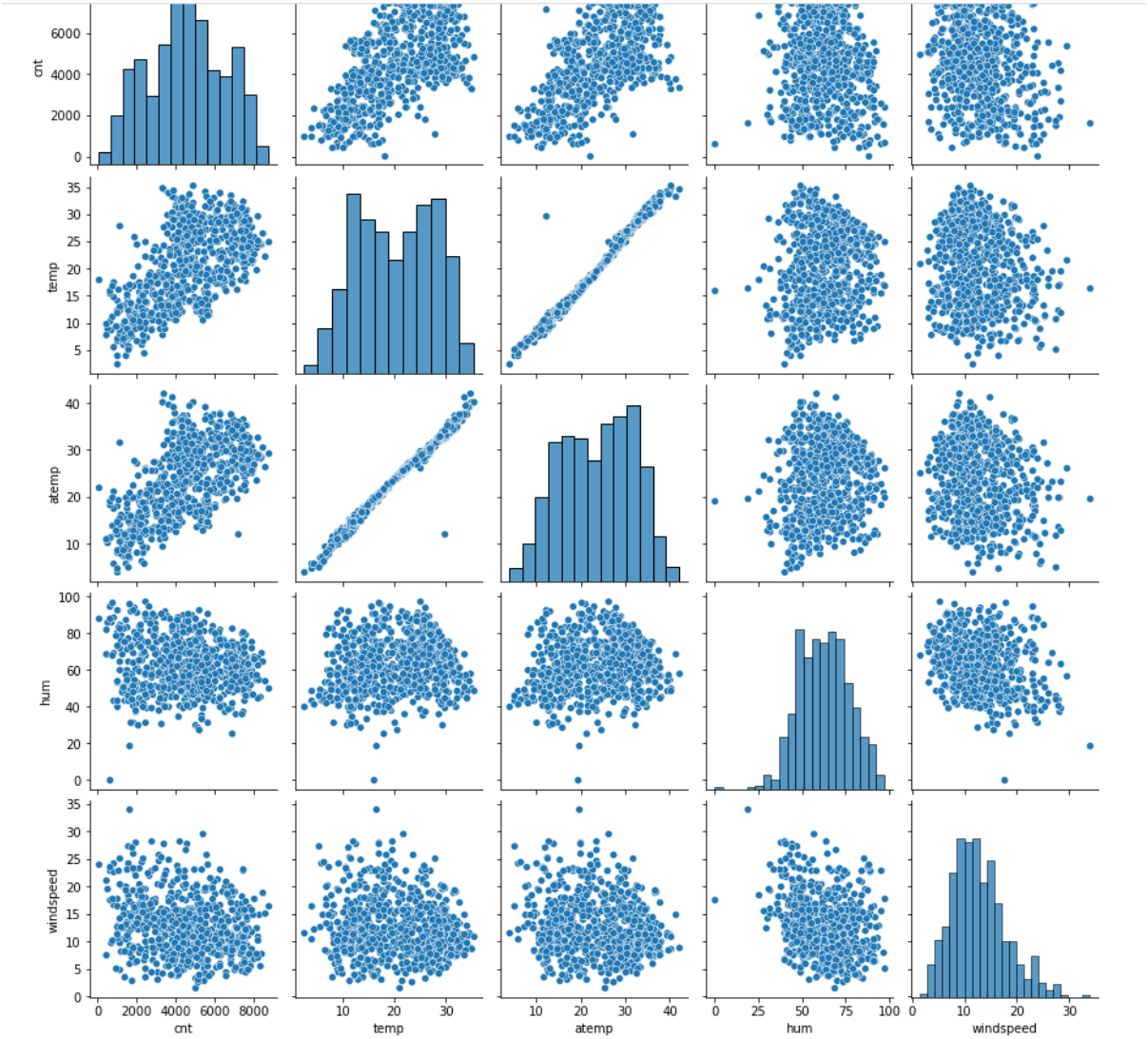
drop_first=True is important to use, as it helps in reducing the extra column created during dummy variable creation. Hence it reduces the correlations created among dummy variables.

e.g.- Let's say we have 3 types of values in Categorical column and we want to create dummy variable for that column. If one variable is not furnished and semi_furnished, then It is obvious unfurnished. So we do not need 3rd variable to identify the unfurnished.

Hence if we have categorical variable with n-levels, then we need to use n-1 columns to represent the dummy variable.

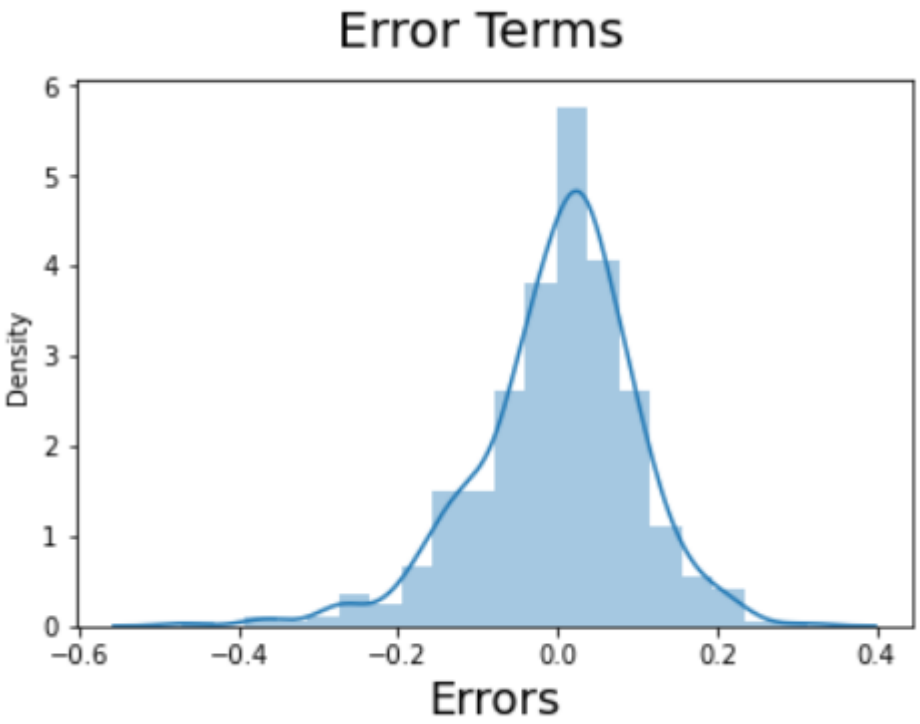
3. Looking at the pair-plot among the numerical variables, which one has the highest correlation with the target variable? (1 mark)

**Ans:-** Looking at the pairplot in Step 2 of the python notebook, 'temp' and 'atemp' have the highest correlation with the target variable 'cnt'



4. How did you validate the assumptions of Linear Regression after building the model on the training set? (3 marks)

**Ans:-** We validate the assumption about residuals by plotting a distplot of residuals and verify if residuals are following normal distribution and centred around 0, which we see is true in the Step 7: Residual Analysis of the train data




5. Based on the final model, which are the top 3 features contributing significantly towards explaining the demand of the shared bikes

**Ans:-**

The below variables have significant effect on demand of shared bikes

1. **Temp** having a positive co-efficient of **0.4758**
2. **Yr** having a positive co-efficient of **0.2350**
3. **Weathersit- Light Snow**, Light Rain + Thunderstorm + Scattered clouds, Light Rain + Scattered clouds having a negative co-efficient of **-0.2562**

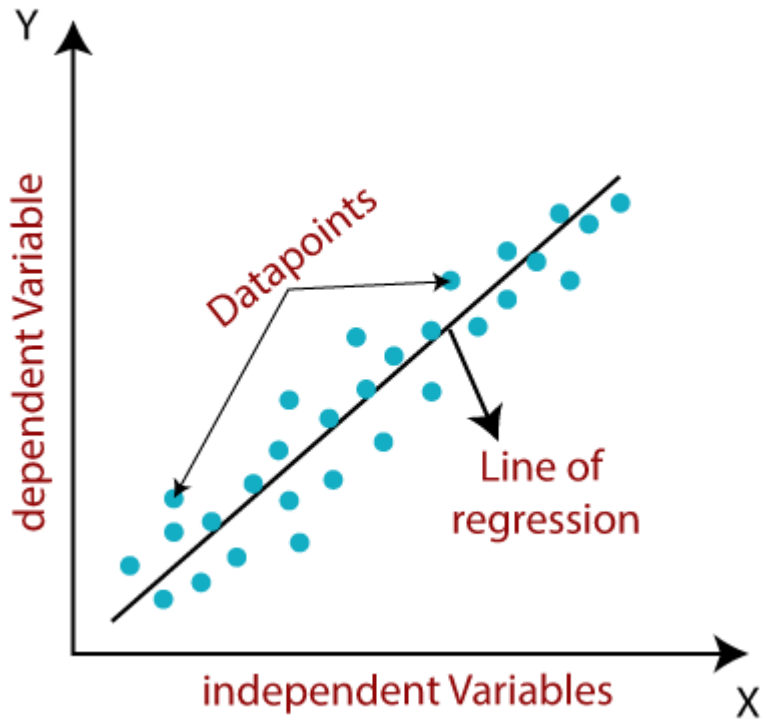
# General Subjective Questions

1. Explain the linear regression algorithm in detail. (4 marks)

Linear regression is one of the easiest and most popular Machine Learning algorithms. It is a statistical method that is used for predictive analysis. Linear regression makes predictions for continuous/real or numeric variables such as **sales, salary, age, product price,** etc.

Linear regression algorithm shows a linear relationship between a dependent (y) and one or more independent (y) variables, hence called as linear regression. Since linear regression shows the linear relationship, which means it finds how the value of the dependent variable is changing according to the value of the independent variable.

The linear regression model provides a sloped straight line representing the relationship between the variables. Consider the below image:




$y= a_0+a_1x+ \varepsilon$

**Here,**

Y= Dependent Variable (Target Variable)
X= Independent Variable (predictor Variable)
a0= intercept of the line (Gives an additional degree of freedom)

a1 = Linear regression coefficient (scale factor to each input value).
ε = random error

The values for x and y variables are training datasets for Linear Regression model representation.

### Types of Linear Regression

Linear regression can be further divided into two types of the algorithm:

**Simple Linear Regression:**
If a single independent variable is used to predict the value of a numerical dependent variable, then such a Linear Regression algorithm is called Simple Linear Regression.

**Multiple Linear regression:**
If more than one independent variable is used to predict the value of a numerical dependent variable, then such a Linear Regression algorithm is called Multiple Linear Regression

## 2. Explain the Anscombe's quartet in detail. (3 marks)

Anscombe's quartet comprises four datasets that have nearly identical simple statistical properties, yet appear very different when graphed. Each dataset consists of eleven (x,y) points. They were constructed in 1973 by the statistician Francis Anscombe to demonstrate both the importance of graphing data before analyzing it and the effect of outliers on statistical properties.

**Simple understanding:**

Once Francis John "Frank" Anscombe who was a statistician of great repute found 4 sets of 11 data-points in his dream and requested the council as his last wish to plot those points. Those 4 sets of 11 data-points are given below.

| I | | II | | III | | IV | |
|---|---|---|---|---|---|---|---|
| x | y | x | y | x | y | x | y |
| 10.0 | 8.04 | 10.0 | 9.14 | 10.0 | 7.46 | 8.0 | 6.58 |
| 8.0 | 6.95 | 8.0 | 8.14 | 8.0 | 6.77 | 8.0 | 5.76 |
| 13.0 | 7.58 | 13.0 | 8.74 | 13.0 | 12.74 | 8.0 | 7.71 |
| 9.0 | 8.81 | 9.0 | 8.77 | 9.0 | 7.11 | 8.0 | 8.84 |
| 11.0 | 8.33 | 11.0 | 9.26 | 11.0 | 7.81 | 8.0 | 8.47 |
| 14.0 | 9.96 | 14.0 | 8.10 | 14.0 | 8.84 | 8.0 | 7.04 |
| 6.0 | 7.24 | 6.0 | 6.13 | 6.0 | 6.08 | 8.0 | 5.25 |
| 4.0 | 4.26 | 4.0 | 3.10 | 4.0 | 5.39 | 19.0 | 12.50 |
| 12.0 | 10.84 | 12.0 | 9.13 | 12.0 | 8.15 | 8.0 | 5.56 |
| 7.0 | 4.82 | 7.0 | 7.26 | 7.0 | 6.42 | 8.0 | 7.91 |
| 5.0 | 5.68 | 5.0 | 4.74 | 5.0 | 5.73 | 8.0 | 6.89 |

After that, the council analyzed them using only descriptive statistics and found the mean, standard deviation, and correlation between x and y.

## 3. What is Pearson's R? (3 marks)

Pearson's r is a numerical summary of the strength of the linear association between the variables. It value ranges between -1 to +1. It shows the linear relationship between two sets of data.
In simple terms, it tells us can we draw a line graph to represent the data?
r = 1 means the data is perfectly linear with a positive slope
r = -1 means the data is perfectly linear with a negative slope
r = 0 means there is no linear association

## 4. What is scaling? Why is scaling performed? What is the difference between normalized scaling and standardized scaling? (3 marks)

It is a step of data Pre-Processing which is applied to independent variables to normalize the data within a particular range. It also helps in speeding up the calculations in an algorithm.

Most of the times, collected data set contains features highly varying in magnitudes, units and range. If scaling is not done then algorithm only takes magnitude in account and not units hence incorrect modelling. To solve this issue, we have to do scaling to bring all the variables to the same level of magnitude.
It is important to note that **scaling just affects the coefficients** and none of the other parameters like **t-statistic, F-statistic, p-values, R-squared**, etc.

Normalization is generally used when you know that the distribution of your data does not follow a Gaussian distribution. This can be useful in algorithms that do not assume any distribution of the data like K-Nearest Neighbors and Neural Networks.

Standardization, on the other hand, can be helpful in cases where the data follows a Gaussian distribution. However, this does not have to be necessarily true. Also, unlike normalization, standardization does not have a bounding range. So, even if you have outliers in your data, they will not be affected by standardization.

## 5. You might have observed that sometimes the value of VIF is infinite. Why does this happen? (3 marks)

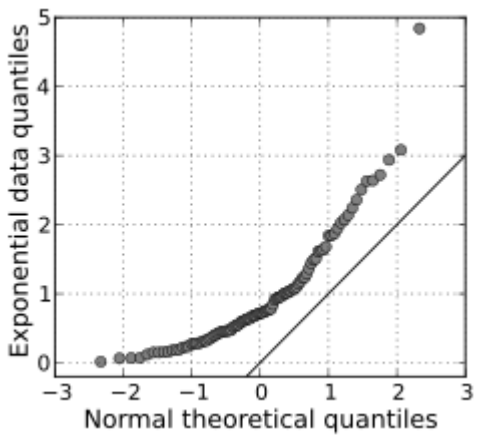
If there is perfect correlation, then VIF = infinity. This shows a perfect correlation between two independent variables. In the case of perfect correlation, we get R2 =1, which lead to 1/(1-R2) infinity. To solve this problem we need to drop one of the variables from the dataset which is causing this perfect multicollinearity.

An infinite VIF value indicates that the corresponding variable may be expressed exactly by a linear combination of other variables (which show an infinite VIF as well).

## 6. What is a Q-Q plot? Explain the use and importance of a Q-Q plot in linear regression. (3 marks

Q-Q Plots (Quantile-Quantile plots) are plots of two quantiles against each other. A quantile is a fraction where certain values fall below that quantile. For example, the median is a quantile where 50% of the data fall below that point and 50% lie above it. The purpose of Q Q plots is to find out if two sets of data come from the same distribution. A 45 degree angle is plotted on the Q Q plot; if the two data sets come from a common distribution, the points will fall on that reference line.

A Q Q plot showing the 45 degree reference line:



If the two distributions being compared are similar, the points in the Q–Q plot will approximately lie on the line y = x. If the distributions are linearly related, the points in the Q–Q plot will approximately lie on a line, but not necessarily on the line y = x. Q–Q plots can also be used as a graphical means of estimating parameters in a location-scale family of distributions.

A Q–Q plot is used to compare the shapes of distributions, providing a graphical view of how properties such as location, scale, and skewness are similar or different in the two distributions.

The q-q plot help us give insights to the below: -

- Do two data sets come from populations with a common distribution?
- Do two data sets have common location and scale?
- Do two data sets have similar distributional shapes?
- Do two data sets have similar tail behavior?